



## DECLARATION

I, Hiroshi MINAGAWA of c/o KOYO INTERNATIONAL TECHNICAL INSTITUTE. INC., Nikko Kagurazaka Building, 18 Iwato-cho, Shinjuku-ku, Tokyo, Japan, do hereby solemnly declare that the attached pages contain an accurate translation of the official certified copy of Japanese Patent Application No. 2003-163521 to the best of my knowledge.

Declared at Tokyo, Japan

This 2nd day of November, 2005



A handwritten signature in black ink, appearing to read "Hiroshi Minagawa".

Hiroshi MINAGAWA



[ DOCUMENT] Patent Application

[ REFERENCE NUMBER] DKT2627465

[ DESTINATION] Commissioner of Patent Office, Esq.

[ INTERNATIONAL PATENT CLASSIFICATION] G03B 15/08 113

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[ INDICATION OF CHARGE]

[ PREPAYMENT LEDGER NUMBER] 201526

[ PAID AMOUNT] ¥21,000

[ LIST OF FILED DOCUMENTS]

[ TYPE OF DOCUMENT] Specification 1

[ TYPE OF DOCUMENT] Drawings 1

[ TYPE OF DOCUMENT] Abstract 1

[ GENERAL POWER OF ATTORNEY NUMBER] 9106133

[ NECESSITY OF PROOF] Necessary

[ DOCUMENT] SPECIFICATION

[ TITLE OF THE INVENTION] TONER SUPPLYING APPARATUS

[ PATENT CLAIM]

[ Claim 1] A toner supplying apparatus for supplying a mixed fluid containing a toner and an air stream to a developing device from a toner storage which is disposed apart from the developing device, through a transferring pipe by a fluid transferring member for supplying the toner, comprising:

a toner separating member communicating to the developing device, which separates the toner from the mixed fluid; and

rotary valves each of which is enclosed with a housing, between the toner separating member which separates the toner from the mixed fluid and the developing device and between a toner hopper provided in the toner storage and a toner mixing chamber.

[ Claim 2] The toner supplying apparatus of claim 1, wherein the rotary valve is arranged to have a clearance of 0.1mm to 0.7mm between edges of a bladed wheel and an inside wall of the housing.

[ Claim 3] The toner supplying apparatus of claim 1 or 2, comprising a plurality of rotary valves in series in a streaming path of the mixed fluid.

[ Claim 4] The toner supplying apparatus of any one of claims 1-3, wherein the rotary valve has a bladed wheel with 4 to 12 blades.

## [ DETAILED DESCRIPTION OF THE INVENTION]

[ 0001]

## [ Technical Field of the Invention]

The invention relates to a toner supplying apparatus in an electrophotographic system of image forming apparatus, and to an image forming apparatus.

[ 0002]

## [ Conventional Art]

The image forming apparatus has a problem of a difficulty from a mechanical space point of view in disposing a toner storage for storing a toner in the vicinity of a developing device because of a large volume of the storage.

[ 0003]

In order to solve such a problem, a toner supplying technology has been disclosed for transferring the toner from the toner storage to the developing device by using a toner transferring method called an air-transfer that can transfer the toner far.

[ 0004]

The toner supplying apparatus using the air-transfer method basically includes a toner storage having a toner mixing chamber, a fluid transferring member for transferring mixed fluid of the toner and air-stream from the toner storage, and a toner separating member for separating the toner from the transferred mixed fluid.

[ 0005]

A part of the air-stream separated from the toner is usually returned to the mixing chamber via the fluid transferring member without discharging outside. Sometimes the toner separating member has been provided with a filter for preventing the toner from scattering outside and for releasing only a part of the air-stream outside to adjust the air pressure within a supply path. There has been also disclosed a technology of returning the air-stream in a developing device to a toner supplying apparatus passing through a transferring pipe between the developing device and the toner supplying apparatus, or a technology of returning the air-stream outside through a filter provided on a developing device. Further disclosed is a technology in which a bladed wheel called a rotary valve and a seal are provided between a developing device and a mixed fluid transferring part to avoid toner scattering from the developing device (for example, refer to Patent Document 1).  
JP-Tokukaihei-11-242416A.

[ 0006]

[ Patent Document 1]

JP-Tokukaihei-11-242416A

[ 0007]

[ Problem to be Solved by the Invention]

However, in the method of returning the air-stream in the developing device to the toner supplying apparatus through the transferring pipe connecting between the supplying apparatus and the developing device, if the

transferring pipe is long, air-flow resistance inside the transferring pipe increases so that the air-stream within the developing device cannot return to the toner supplying apparatus in a short time, thereby there is a large possibility of scattering the toner from the developing device.

[ 0008]

In the method of providing the developing device with a filter to release the air-stream to the outside, the filter needs to be exchanged periodically, which is troublesome, and missing the periodic exchange of filter causes the filter to be clogged to prohibit the air-stream from passing through the filter, thereby scattering the toner from the developing device may cause.

[ 0009]

In the method of providing the rotary valve and the seal between the developing device and the fluid transferring part, long-time rotation of the bladed wheel of the rotary valve causes the toner to enter a sliding part between the edges of the blades and the seal with resultant melting and sticking of the toner.

[ 0010]

An object of the present invention is to provide a toner supplying apparatus to enable supplying a toner stably to a developing device, in order to avoid the above-described problem.

[ 0011]

[ Means for Solving the Problem]

The object of the invention is achieved by a toner supplying apparatus for supplying a mixed fluid containing a toner and an air stream to a developing device from a toner storage which is disposed apart from the developing device, through a transferring pipe by a fluid transferring member for supplying the toner, comprising: a toner separating member communicating to the developing device, which separates the toner from the mixed fluid; and rotary valves each of which is enclosed with a housing, between the toner separating member which separates the toner from the mixed fluid and the developing device and between a toner hopper provided in the toner storage and a toner mixing chamber.

[ 0012]

[ Embodiment of the Invention]

A first embodiment of the invention will be explained with reference to the accompanying drawings. The description is not intended as a limitation of the scope of the claims nor a definition of the limits of the terms in the claims.

[ 0013]

FIG. 1 is a schematic illustration showing the overall construction of an image forming apparatus equipped with the toner supplying apparatus.

[ 0014]

In an automatic document feeding device 20 of FIG. 1,

documents placed on a document table are fed one by one to a reading position, and stacked in a document discharge tray after reading the documents.

[ 0015]

A document reading section 21 reads an image on a document and produces digital image data.

An image forming section 22 forms an image on a recording sheet using an electro-photographic method.

[ 0016]

In the image forming section 22, there are arranged around a drum-like photosensitive body (image bearing member) 1; a charging device 2, an exposing device 3, a developing device 4, a transferring device 5, a detaching device 6 and a cleaning device 7. Under the image forming device 22, there is provided a paper feed section 23 including a plurality of recording sheets storages, from which a recording sheet is transferred to the image forming section 22. Reference numeral 10 denotes a paper feed section for manual feeding. A recording sheet fed from the paper feed sections 23 or 10 is supplied by registration rollers 11 to a position between the photosensitive body 1 and the transferring device 5, applied a fixing process by a fixing device 8, and discharged to a discharging tray 12.

[ 0017]

Corresponding to the clockwise rotation of the photosensitive body 1, the body 1 is charged by the charging device 2, exposed an image by the exposing device

3, and developed by the developing device 4, whereby a toner image is formed on the body 1. The formed toner image is then transferred on the recording sheet by the transferring device 5. The recording sheet with the toner image transferred thereon is fixed by the fixing device 8, and then discharged to the discharging tray 12.

[ 0018]

The developing device 4 develops an electrostatic latent image on the photosensitive body 1, using a two-component developer composed of a toner and a carrier or a mono-component developer that contains a toner without a carrier or contains a toner and additives. The developing device 4 stores a predetermined amount of developer, and the toner consumed by the development is replenished from a toner storage (to be explained below) 24 of the toner supplying apparatus to maintain the toner concentration of the developer in the developing device to a predetermined value. When using the mono-component toner, the developer amount in the developing device is maintained to the predetermined value with the similar toner supply.

[ 0019]

On the toner storage 24, a toner container 31 is mounted. The toner storage 24 includes a toner hopper 30 and a funnel-like mixing chamber 35 for mixing the toner and the air-stream. A toner separating member 60 which is located near the developing device 4 and the toner storage 24 which is disposed apart from the developing device 4 are

connected to each other through transferring pipes 40-43 acting as toner transporting conduits. Each of the transferring pipes 40-43 is composed partly of a flexible member made of silicone rubber or fluorocarbon resin, and partly of a metal pipe.

[ 0020]

The toner supplying apparatus will now be explained with reference to FIGS. 2 and 3.

FIG.2 illustrates the toner supplying apparatus used in the image forming apparatus shown in FIG.1, and FIG.3 illustrates the toner storage.

[ 0021]

Referring to FIG. 2, the toner supplying apparatus includes the toner storage 24, pumps 501 and 502 as fluid transferring members for supplying and for returning, respectively, the toner separating member 60, and the transferring pipes 40-43 acting as toner transporting conduits.

[ 0022]

Referring to FIG. 3, the cylindrical toner container 31 is mounted on the toner storage 24 (see FIGS. 1 and 2), and rotated by a motor 38, which causes the toner to fall from the container 31 into the toner hopper 30 through an opening 30a (the toner is mixed with the air and stored in the toner container and therefore it is considered to be mixed fluid). The toner hopper 30 includes a bar-type stirring member 32 having a plurality of U-shaped parts

formed thereon, and a feeding screw 34 disposed at the lower part.

[ 0023]

Rotation of a motor 39 causes the stirring member 32 and the screw 34 to rotate to let fall the toner from the hopper 30 into the mixing chamber 35 through an opening 30b.

[ 0024]

Between the opening 30b and the mixing chamber 35, there is provided a rotary valve 36 (to be described later).

[ 0025]

The air flows into the mixing chamber 35 through the transferring pipe 43 to mix the air-stream and the toner to form mixed powder (mixed fluid).

[ 0026]

FIG. 4 is a sectional view showing the structure of a diaphragm pump.

As for the fluid transferring member for supplying (returning) toner, the diaphragm pumps 501 and 502 shown in FIG. 4 are employed, but there may be employed any known pumps, such as a screw pump disclosed in JP-Tokukaihei-7-219329A, fans, or the like. The pump 501 constitutes the fluid transferring member for supplying the toner for feeding the mixed fluid from the mixing chamber 35 to the toner separating member 60 (see FIG. 2), and the pump 502 constitutes the fluid transferring member for returning the toner with air-stream, which is not separated, from the toner separating member 60 to the mixing chamber 35. In

the embodiment shown in FIG.2, the same structure of pumps are used for the pumps 501 and 502, but the fluid transferring member for supplying the toner may differ from that for returning the toner.

[ 0027]

The pumps 501 and 502 will be explained referring to FIG. 4. Both pumps 501 and 502 have the same structure as shown in FIG. 4.

[ 0028]

The pump 501 is connected at its inlet with the pipe 40, and is connected at its outlet with the pipe 41. The pump 502 is connected at its inlet with the pipe 42, and is connected at its outlet with the pipe 43. A pump chamber enclosed by an outer wall 50 is partitioned into a suction chamber 50a and a discharge chamber 50b by an inside wall 51. At an inlet of the suction chamber 50a, a valve 53 is provided, and at a vent of the discharge chamber 50b (a vent on the inside wall 51), a valve 54 is provided.

[ 0029]

A part of outer housing of the pump 501 or 502 is formed with a diaphragm 52 made of elastic material like rubber. The diaphragm 52 is driven by an eccentric rotating member 56, which is driven by a motor 55a (55b), to be transformed between the states indicated by solid lines and broken lines.

[ 0030]

The rotation of the eccentric rotating member 56 by

the motor 55a (55b) causes the diaphragm 52 to be transformed between the states indicated by solid lines and broken lines, whereby the volume of the suction chamber 50a changes so as to increase or decrease the pressure of the chamber 55a. This increase or decrease of the pressure causes the valves 53 and 54 to move between the positions indicated by solid lines or broken lines, to thereby feed the fluid to a one-side direction shown by an arrow.

[ 0031]

In a conventional technique, fluctuation of the rotational speed of the motor 55a (55b) or the like sometimes causes to lose a pressure balance between the pipe 41 side and the pipe 42 side. In order to reduce this pressure change, the toner separating member 60 has been provided with a filter in the past to release a part of the air-stream outside to adjust the air pressure. However, as described before, clogging of the filter in a short term causes the occurrence of toner scattering, which requires the periodic exchange of filter, troublesome operation.

[ 0032]

Further, when the toner transferring pipes are long, higher air-flow resistance in the pipes needs to be used large capacity motors, but sometimes causes the air-stream to flow backward into the hopper 30, or to leak into the developing device, to thereby scatter the toner.

[ 0033]

In order to reduce the influence of aforementioned

pressure change in the toner streaming path, the embodiment provides a rotary valve in the toner streaming path, and feeds the toner by rotating a bladed wheel in the valve when necessary.

[ 0034]

A description will be given of the rotary valve.

As shown in FIG. 2, a rotary valve 36 prevents the toner returned through the transferring pipe 43 from flowing backward to the hopper 30. A rotary valve 37 is disposed between the toner separating member 60 located near the developing device and the toner storage buffer 47 which is a part of the developing device 4, for preventing the air-stream from flowing into the developing device, to thereby prevent toner scattering from the developing device 4. In order to avoid the toner to be melted and stuck between the edges of the bladed wheel 36b or 37b and the inside wall of the housing 36a or 37a, it is preferable that the rotary valve 36 or 37 has a minimum clearance ranging from 0.1 mm to 0.7 mm between the edge of the blade 36b or 37b and the inside wall of the housing 36a or 37a.

[ 0035]

In order to improve the effect of preventing the leak of mixed fluid, plural rotary valves may be preferably provided in series, and the bladed wheel preferably has 4 to 12 blades.

[ 0036]

The rotary valves 36 and 37 are simultaneously driven

with the drive of the toner transferring screws 34 and 68, respectively.

[ 0037]

A description will now be given of a toner supplying process referring to FIGS. 2 to 4.

Toner amount in the toner hopper 30 is detected by the toner sensor 33 using a piezoelectric element. When a toner level becomes lower than the level detected by the sensor 33, the motor 38 is actuated to rotate the container 31, which allows the toner to be replenished into the hopper 30 through the opening 30a.

[ 0038]

When a toner concentration of the developer within the developing device becomes lower than a predetermined value, a concentration sensor which is not shown detects the state. A controller 70, receiving a detection signal, rotates a screw 49 to replenish a toner to the developing device 4, which causes the toner in the toner storing buffer 47 to be supplied to the developing device 4. When the toner concentration returns to the predetermined value, the instruction to replenish the toner is cancelled, and a series of feeding operation stops.

[ 0039]

The toner storing buffer 47 is provided with a piezoelectric sensor 44 to keep the toner amount constant. When the toner level is lowered, the sensor 44 transmits a signal to the controller 70, which instructs the drivers of

pumps, screws, and rotary valves to be operated.

[ 0040]

In detail, actuation of the motor 39 shown in FIG. 3 drives the stirring member 32 to stir the toner inside the hopper 30, and also drives the screw 34 to drop the toner into the mixing chamber 35. At the same time, the rotary valve 36 is actuated, and also pump motors 55a and 55b are energized to operate the pumps 501 and 502, respectively. The operation of the pumps 501 and 502 generates an air stream in the mixing chamber 35 to mix the toner and the air-stream, and feeds the mixed fluid to the separating member 60 through the transferring pipes 40 and 41 by feed force of the pump 501.

[ 0041]

The toner separated by the separating member 60 is transferred by the screw 68, fed to the storing buffer 47 by simultaneous operation of the valve 37, and also supplied to the developing device 4. The mixed fluid of the toner and air-stream that is not separated is returned to the mixed chamber 35 through the transferring pipes 42 and 43 by feed force of the pump 502.

[ 0042]

As described above, installation of the rotary valves prevents the returned mixed fluid from leaking outside, to thereby avoid inconvenience such as toner scattering as much as possible.

[ 0043]

According to the above-described toner supplying system, the following effects can be attained.

[ 0044]

[ Advantageous Effect of the Invention]

(1) Even if the toner transferring amount is increased by using a large capacity of pump motor, toner scattering can be avoided.

[ 0045]

(2) Since the toner container (cassette), the toner storage or the like can be disposed apart from the developing device, a large size of toner supplying apparatus can be installed, corresponding to customers that need volumes of printouts, for example, in a print-on-demand (POD) market and the like.

[ 0046]

(3) The number of feeding screws can be reduced as much as possible, thereby reducing the stress on the toner to a minimum.

[ 0047]

(4) It is also possible to design a machine body with higher flexibility for the layout of a toner supplying apparatus.

[ BRIEF DESCRIPTION OF THE DRAWINGS]

[ FIG. 1]

This is a schematic illustration showing the overall construction of an image forming apparatus including a toner supplying apparatus according to the present

invention.

[ FIG. 2]

This illustrates the toner supplying apparatus in the image forming apparatus shown in FIG. 1.

[ FIG. 3]

This illustrates a toner storage.

[ FIG. 4]

This is a sectional view showing the structure of a diaphragm pump.

[ Explanation of Reference Numeral]

- 1 photosensitive body
- 24 toner storage
- 30 toner hopper
- 35 mixing chamber
- 36, 37 rotary valve
- 36a, 37a inside wall
- 36a, 36b bladed wheel
- 40, 41, 42, 43 transferring pipe
- 501, 502 pump
- 55a, 55b pump motor

[ DOCUMENT] ABSTRACT

[ ABSTRACT]

[ OBJECT] It is to provide a toner supplying apparatus using air transferring by mixed fluid containing an air and a toner, to avoid scattering of toner and to enable transferring toner stably.

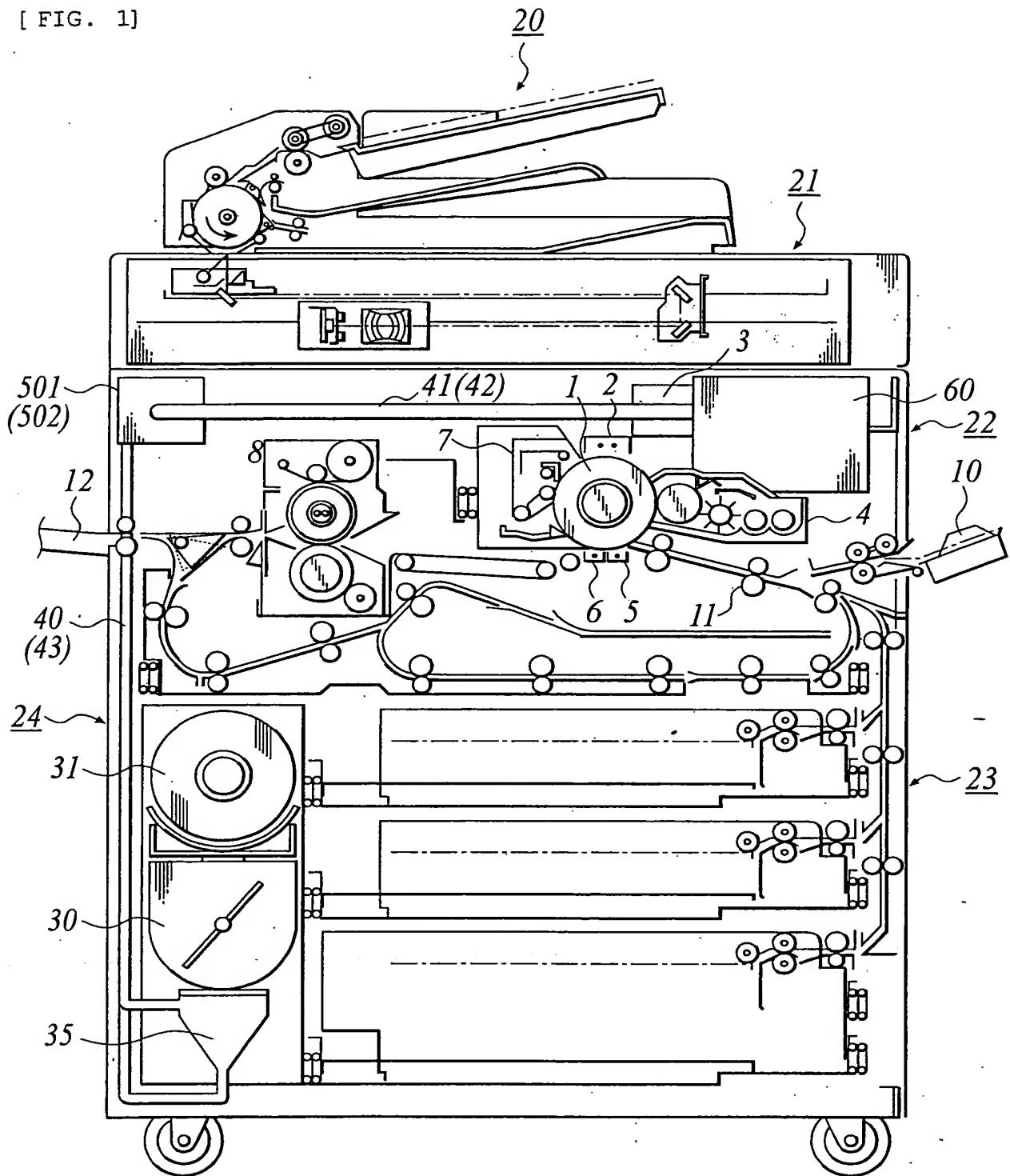
[ SOLVING MEANS] A toner supplying apparatus for supplying a mixed fluid containing a toner and an air stream to a developing device from a toner storage which is disposed apart from the developing device, through a transferring pipe by a fluid transferring member for supplying the toner, including: a toner separating member communicating to the developing device, which separates the toner from the mixed fluid; and rotary valves each of which is enclosed with a housing, between the toner separating member which separates the toner from the mixed fluid and the developing device and between a toner hopper provided in the toner storage and a toner mixing chamber.

[ SELECTED FIGURE] FIG. 2



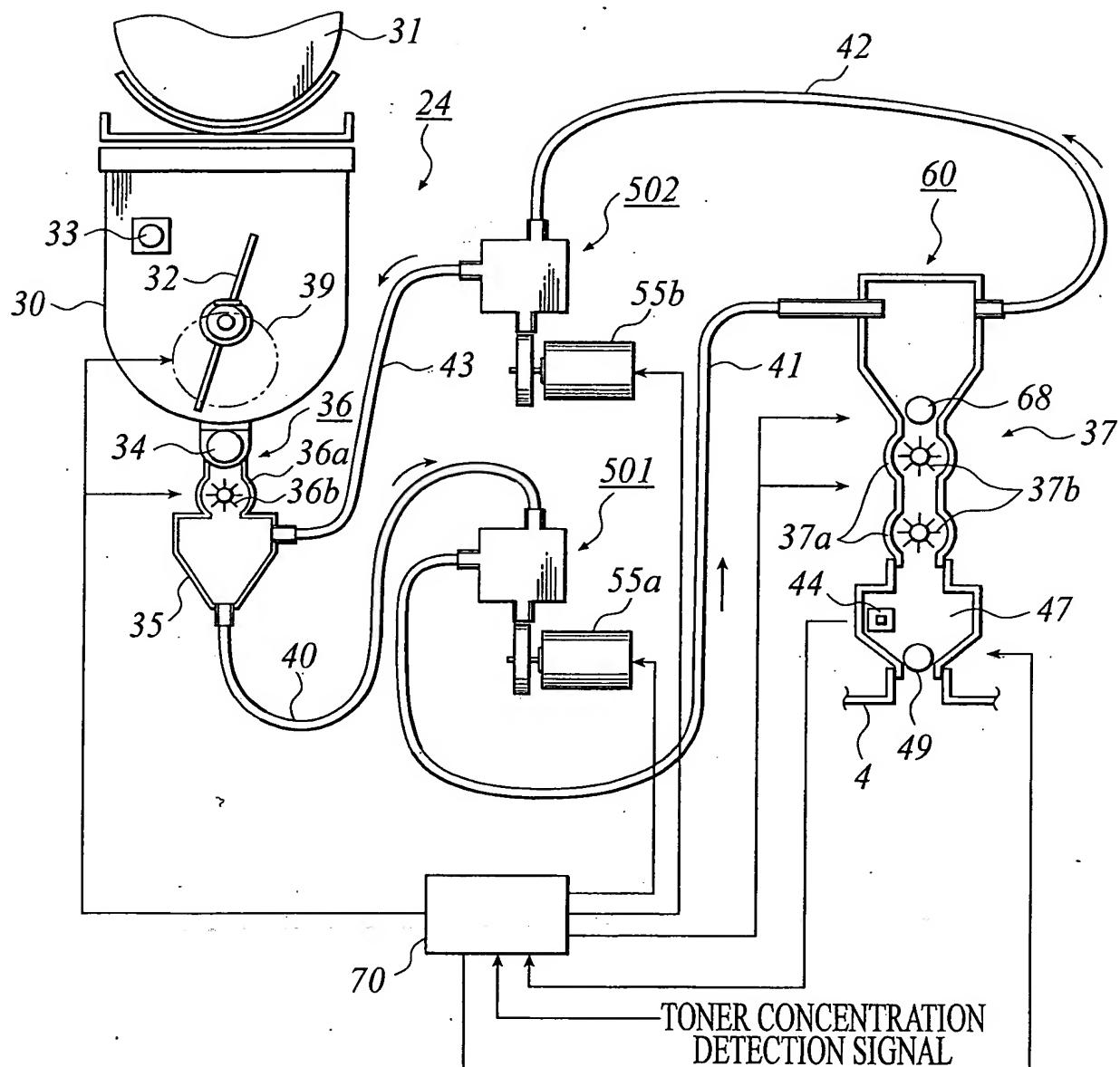
[ DOCUMENT] DRAWINGS

[ FIG. 1]



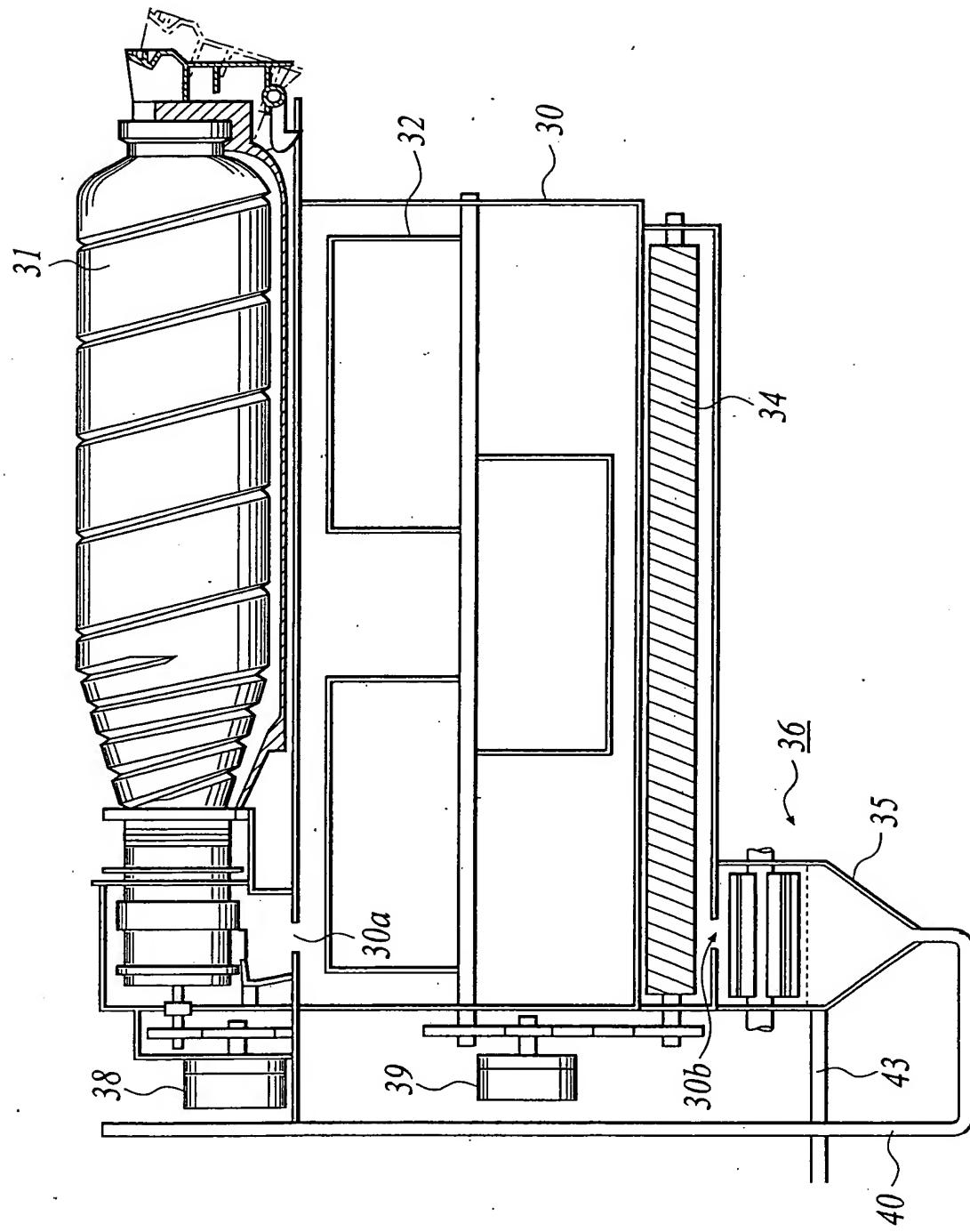


[ FIG. 2]





[ FIG. 3]





[ FIG. 4]

